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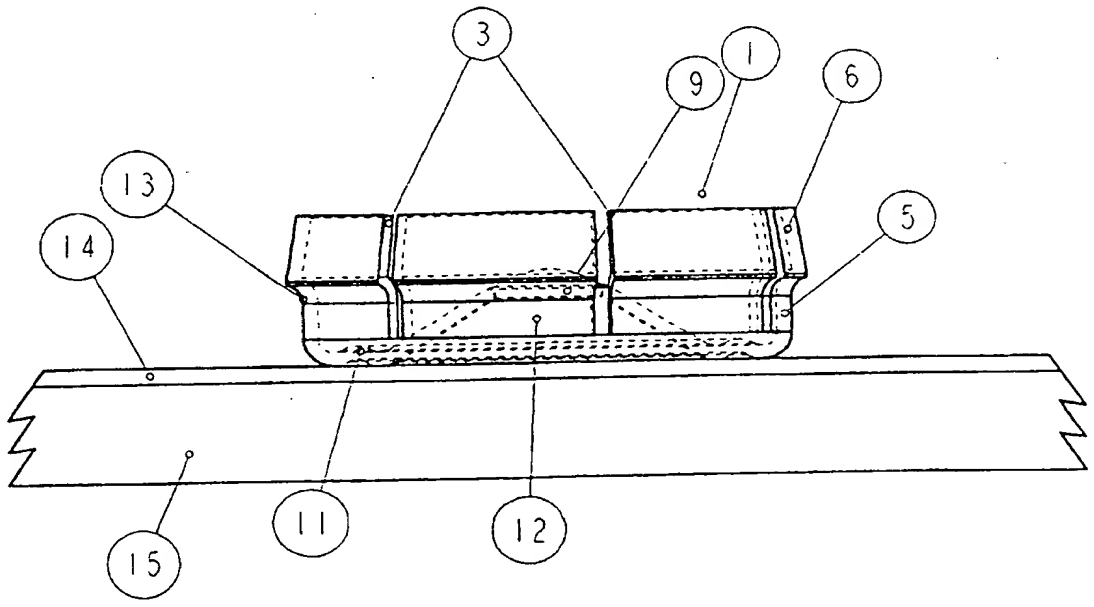

(57) Abstract

A terminal stud (1) to be applied to an electrically conductive material (14) on a glass surface (15) to form a strong unobtrusive connection for an electrical supply wire is provided by a stud comprising a hollowed base plate (7) to receive solder to secure the stud to the conductive material (14), the said base plate (7) having an outer periphery to contact the conductive material (14), the stud further comprising a rim (5, 6) extending from the said outer periphery in a direction externally to the said base plate (7) to provide an attachment for a connecting clip (2) of an electrical supply lead. The stud (1) is particularly concerned with the provision of electrical supply to a conductive material carried on the surface of a window such as a vehicle window.

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Electrical Connection Stud

The present invention relates to an electrical connection stud for use in connecting an electrical supply wire to a conductive element on a glass surface. It is particularly concerned with the provision of an electrical supply to a conductive material carried on the surface of a window such as a vehicle window.

Electrically conductive materials, for example in the form of coatings, grids and ribbons, are increasingly being employed on glass surfaces for a variety of purposes. Electrically conductive coatings or grids are employed as heating elements for automobile windscreens and rear windows, for windscreens on aircraft and railway trains and even as heated glazing panels for buildings. The window heating elements commonly comprise a conductive collector strip at each side of the window, with horizontal conductive filaments extending across the width of the window from one collector strip to the other, but may alternatively be a thin uniform conductive layer across the whole window surface. Conductive coatings, grids or ribbons are alternatively used as radio antenna. Conductive ribbons are used as alarm wiring on glazing panels, triggering an alarm signal if the ribbon is broken.

There have been many prior proposals for the configuration and location of terminals for such elements. It is a common aim for the terminal to provide a firm and reliable contact with the conductive element, while being shaped and located to be as unobtrusive as possible. In general the terminal is firmly secured to the element by soldering. Problems tend to be caused in heated windows by stresses which arise at the interface between the glass and the terminal as a result of the difference between the thermal expansion coefficients of the glass and of the metal constituting the terminal or of a metallic conductor to which the terminal is attached. Because the terminal is normally small it tends to provide a significant local concentration of heat, which affects both the adjacent glass and the solder holding the terminal in place. The stresses appear especially during the soldering of the said terminal to the element, in the operation of a heating element and when the glass is exposed to heat such as solar radiation. They can lead to the terminal breaking away from the glass and to fissures in the glass in the vicinity of the terminal. Many of the prior proposals have therefore been directed to reducing such

stresses.

Another problem is that many of the prior proposed terminals have free or projecting portions which tend to scratch adjacent glass panels during transport or stacking before their installation. This requires flexible exposed parts of the terminal to be covered and/or held in a less obtrusive position on the panel by such means as adhesive tape.

French patent specification 2670070 (070) describes glass panels with conductive elements, especially for the heated rear window of a vehicle, in which the terminals are provided with small projections on the face in contact with the glass such that the projections prevent the securing solder being squeezed out of position. In the specific configuration illustrated in 070 the terminal is constituted of a flat portion generally in the form of an "E" of which the outer side arms are soldered to the element and the inner side arm, which is longer than the outer side arms, is free to receive a connecting terminal which is attached the electrical supply wire for the element.

European Patent 0023121 claims a heated window terminal with a connecting arm (a lead area) to which an electrical connection can be made and at least one bonding foot so shaped that a first planar portion of each bonding foot is in close proximity to the heating grid and a second planar portion of each bonding foot is soldered to the heating grid. Its illustrated version includes two such bonding feet.

French patent specification 2630863 relates to an electrical connection terminal on a support such as a glazing panel. The terminal comprises a base plate, typically in the form of an "E" or a "C", to be attached over at least part of its surface to a collector on the support and to a projection which extends perpendicular to the base. The projection, which is preferably cylindrical or conical, is connectable to a complementary piece which is in turn connected to a supply wire. The complementary piece is intended to be attached to the projection by applying pressure perpendicular to the base.

Belgian patent 792573 relates to a glazing sheet carrying an electrical circuit, in particular an automobile windscreen carrying a radio antenna formed of a metallic ribbon in the form of a "T", in which the circuit has an enlarged end portion and a connection terminal is attached to the enlarged end portion. It illustrates a connection terminal soldered to the end portion and constituted of a hollow cylinder with a circular base plate of slightly larger a diameter than the cylinder. A connecting wire to the radio is inserted into a lateral orifice in the cylinder, which is internally threaded to receive a securing screw.

French patent specification 2618264 relates to an electrical supply terminal for glazing with electrical conductors or electrical equipment, the terminal being in the form of a hollow rivet or of a press stud. The terminal is intended in particular to be encapsulated in a rubber material.

While the prior proposals have to some extent reduced the problems of overheating and scratching their solutions have been cumbersome, for example requiring multi-part terminals, packaging protection or encapsulation of the terminals. Such solutions have involved supplementary costs, not only in materials but also in operations such as placement, removal and in some cases disposal of the respective materials.

The object of the invention is to provide a simple connection terminal with an improved configuration over those known in the art.

According to the invention there is provided a terminal stud to be applied to an electrically conductive material (14) on a glass surface (15), characterised in that the stud comprises a hollowed base plate (7) to receive solder to secure the stud to the conductive material (14), the said base plate (7) having an outer periphery to contact the conductive material (14), the stud further comprising a rim (4) extending from the said outer periphery in a direction externally to the said base plate (7) to provide an attachment for a connecting clip (2) of an electrical supply lead.

The stud is generally located on a portion of the element which serves as conductive collector strip. It provides a convenient point to which to attach a corresponding clip from which extends an electrical supply wire.

Terminal studs according to the invention offer a compact, snag-free terminal having several advantages over the terminals of prior art proposals.

In mechanical terms, the stud's hollow base plate allows for a significant quantity of solder to be disposed between the lower face of the stud and the electrically conductive material on the glass. A hollow surface also presents for adhesion to the solder a more substantial area than a flat surface with the same perimeter. These factors ensure a strong attachment of the stud to the glass. The outer rim permits attachment to the connecting clip over the whole periphery of the stud, thus giving a substantial zone of contact between the stud and clip, with accompanying benefits in the stability of the attachment.

A hollow profile is also more favourable for maintaining molten solder under the base of the stud and thus to avoid any leakage of solder on to the glass. Such leakages are common with the use of flat studs or bases and are both visually unattractive and prejudicial to the detachment resistance of such

studs.

In electrical terms, the significant contact surface existing between the solder and the terminal stud assists the establishment of a good electrical connection between this stud and the conductive material on the glass to which it is fixed. The significant contact surface between the stud periphery and the connecting clip similarly provides a good electrical connection, avoiding the "hot spots" which may arise with connections to a small projection from the conductive material.

In thermal terms, a hollow base stud allows the relatively large surface area of solder in contact with the conductive material to spread the heat generated during the soldering. This reduces the heat concentration applied to the interface between the conductive material and the glass and thus significantly limits the thermal stress applied to the glass during soldering as a result of the different expansion coefficients of the conductive material and the glass.

The format of stud according to the invention allows its manufacture from a single piece of metal into the shape ready to receive the connecting clip. This avoids the problem which arises with many prior terminals of a mobile part which can be inadvertently bent during transport or storage into a position in which it scratches or grips adjacent sheets of glass. The need for protective adhesive tape to hold such a mobile part in position is thus avoided, saving the cost of tape and the process steps involved in applying, removing and disposing of the tape and in cleaning any adhesive residues from the glass.

The hollow base-plate format further allows for easy application of the terminal studs by means of a robot. Indeed the studs can be stacked in a cartridge and distributed at the soldering tip of an automatic device for fixing the studs to the glass. The hollow portion of the studs can conveniently be charged with a pre-formed slug of solder prior to being put into the cartridge.

The stud offers the advantage that it can be of one-piece construction, with the base plate and outer rim being formed from a single metal sheet, typically by a combination of stamping and cutting actions.

Preferably, the terminal stud according to the invention is of circular cross-section in a plane parallel to the plane of the glass. A circular cross-section facilitates dispensing and location of the stud and attaching it to a connecting clip. It avoids positioning problems which arise with a traditional non-circular cross section in the attachment of the stud to the conductive material, since this requires precise orientation of the stud in relation to the

conductive material. The circular cross-section similarly facilitates the action of attaching the stud to the connecting clip.

Preferably, the part of the base plate in contact with the conductive surface includes at least one groove. In the case of a circular stud the groove is preferably a continuous circular groove around the periphery. Such grooves further reduce the surface area of the stud in direct contact with the conductive material, giving a useful reduction in the area of interface between the materials with very different coefficients of thermal expansion, and thereby further reducing any thermal stress at this interface.

Preferably the stud includes at least one orifice extending through the base plate. This permits further release of heat created during the soldering or in the operation of a heated window. It further permits a soldering iron to be applied though an orifice into direct contact with the solder, which is not only more convenient than indirect application but also allows the soldering temperature to be reduced (typically from 270°C to 220°C) and thus to reduce the energy costs of the operation. A further advantage is that the pre-formed slug of solder mentioned above can be clipped into the orifice to be held in position therein during storage in a cartridge stack and during distribution and placement at the soldering point, thereby further facilitating attachment of the stud to the conductive material by a robot.

If a single orifice is employed it is preferably substantially central to the hollow region and preferably of circular shape. If several orifices are employed the preferred configuration is to have one substantially central orifice and at least four orifices disposed around it. The latter orifices are preferably rectangular with the configuration of elongated slots having their longer dimension pointing away from the central orifice and are preferably located equidistant from each other. Multiple orifices offer the advantage of making the base plate more easily deformable and thus to limit the extent of stresses applied to the conductive material and glass during soldering.

In one convenient configuration according to the invention the base plate has a single orifice of generally cruciform shape. The single orifice preferably includes a central generally circular portion, though which the tip of a soldering iron can be passed to effect the soldering, and elongated slots as described above but in this instance opening out from the central portion.

The hollow is of a generally convex shape, although it will be understood that its shape need not follow a regular curve. One possible format is for it to be frusto-conical.

In one convenient embodiment of the invention the stud and the

corresponding clip are shaped to provide a snap fastener. This can be achieved by making the stud rim in the shape of a cone, truncated at the periphery of the base plate of the said stud. For an equal height of the stud, a conical side surface gives a larger area than a cylindrical surface having the same diameter as the base plate periphery. This larger surface promotes heat dissipation during the soldering of the stud or in the operation of a heated element to which it is attached.

Preferably, the outer rim of the stud is provided with a ridge to which the corresponding clip carrying the electrical supply wire can be attached. If the clip includes around its periphery a flexible annulus or flexible teeth these can be made of complementary size to the ridge so as to provide a snap action when the clip is pushed into place on the stud. Such a cooperating fit between the ridge and clip further encourages a firm connection between them, giving little opportunity for the clip to be inadvertently dislodged.

Such a ridge can conveniently be provided by making the rim frusto-conical with its narrower diameter at the end in contact with the periphery of the base plate. In the simplest form of such a frusto-conical rim the ridge is provided by the wider diameter of the frusto-cone. In one alternative form the ridge is provided by a cylindrical portion extending from the said wider diameter of the said frusto-conical portion of the rim. In a further alternative form the ridge is provided by making the rim portion of two frusto conical parts, inverted with respect to each other and with their wider diameters in abutment to create the ridge. In Another alternative form of the stud, the rim comprises a cylindrical portion in contact with the periphery of the base plate and a frusto-conical portion whose wider diameter is in contact with the cylindrical portion of the rim to create a ridge where the said portions join. In this version of the stud, the cylindrical portion of the rim allows the ridge to be larger than with a rim comprising two frusto-conical portions. This promotes a good electrical contact between the stud and the corresponding clip.

Preferably, the rim is provided with slits extending perpendicularly from the periphery of the base-plate to the top of the rim. This configuration facilitates the fastening operation of the corresponding clip. It also promotes heat dissipation during the soldering of the stud.

Preferably, the stud is made of a Cu-based material. Such a material has the advantage of having excellent electrical and thermal conductivities. The corresponding clip can be covered with a cap of any suitable shape and material. This cap is provided especially for aesthetic reasons. Furthermore, it may ensure electrical insulation of the stud and

corresponding clip.

The invention is further described with reference to the accompanying figures, in which:

Figure 1 is a view from below of a low-profile terminal stud according to the invention (i.e. as would be seen, prior to soldering, through a sheet of glass on which the stud is to be mounted).

Figure 2 is a sectional side view of the stud shown in Figure 1, the section being taken along line A-A' of figure 1. In this figure the stud is shown in position on a conductive layer on a glass sheet.

Figure 3 is a view from below of a modified version of the stud shown in Figure 1, having no lateral slits in its rim and having multiple orifices in its base plate but still in accordance with the invention.

Figure 4 is a view from below of a modified version of the stud shown in Figures 1, having no lateral slits in its rim and having a single generally cruciform shape orifice in its base but still in accordance with the invention.

Figure 5 is a side view of an alternative version of stud according to the invention.

Figure 6 is a side view (from the same direction as Figure 4 but on a slightly smaller scale) of a complementary clip to be attached to a stud as shown in Figures 1 to 5and intended to receive and secure an electrical supply wire.

Figure 7 is a plan view of the Figure 6 complementary clip (viewed from above as shown by the arrow F in Figure 6).

Figure 8 is a perspective view, from below, of a Figure 6 clip about to be attached to a Figure 1 stud.

Figure 9 is a perspective view, from below, of a Figure 6 clip attached to a Figure 1 stud.

Figure 10 is a side view of a complementary cap to be attached to a complementary clip as shown in Figure 6,

Figure 11 is a plan view of the Figure 10 cap (viewed from the direction shown by the arrow G in Figure 10).

The studs illustrated in Figures 1-11, indicated generally by the reference numeral 1, are of generally circular configuration. The stud 1 comprises a rim portion 4 and a frusto-conical base plate 7. In Figure 2 it is shown in position on a conductive material 14 which in turn is on a glass sheet 15. When the stud is in position as illustrated in Figure 2, the base plate 7 forms a hollow 12 between the stud 1 and the conductive material 14. The

base plate 7 has a central circular orifice 9. At the region where the base plate 7 and rim portion 4 meet and the stud 1 is to contact the conductive material 14 a circular groove 11 is formed in the face of the stud 1.

The rim portion of the studs illustrated in Figures 1-4 have two complementary cylindrical and frusto-conical parts 5 and 6. Part 5 is in contact with the periphery of the base plate 7 and with part 6. The wider diameter of part 6 is slightly greater than the diameter of part 5, creating a projecting ridge 13 where the said parts join. The total rim portion 5, 6, 13 provides for a particularly convenient attachment of a complementary connecting clip generally similar to that of figures 5-8. The frusto-cone surface 6 is helpful in aligning the clip prior to pushing it into position on the stud. The projecting ridge 13 is of a configuration which permits a firm grip with peripheral teeth on the clip. Lateral slits 3 perpendicular to the base plate 7 periphery are provided in the rim 4. These slits facilitate snap fastening of the complementary clip on the stud and heat dissipation during its soldering.

The versions of stud illustrated in Figures 3 and 4 are generally similar to that shown in Figures 1-2 and like parts are therefore given the same reference numerals as in Figures 1-2, except that the studs of Figures 3 and 4 have no lateral slits. The Figure 3 version differs in that radial rectangular orifices 10 are provided in the base plate 7. The Figure 4 version differs in that the central circular orifice 9 and radial rectangular orifices 10 are combined, by extending the rectangular orifices 10 to meet the central circular orifice 9 and thereby form a single cruciform-shaped orifice 29. This orifice configuration is easier to construct than the separate orifices of the Figure 3 version and gives additional flexibility within the stud when the stud is subjected to heating.

The illustrated stud has an external diameter of 13.5 mm and a height of 4 mm. It is preferably applied to the conductive material 14 from a dispensing cartridge (not shown) with a pellet of solder already in place in the hollow 12. A heated soldering iron (not shown) is then brought into direct contact with the solder through the orifice 9 to cause the solder to melt and solidify. The resolidified solder fills the whole of the hollow space 12 between the stud 1 and the conductive material 14. Much of the heat generated during the soldering is able to escape from hollow space 12 through the orifice 9 and by conduction and radiation from the upper and outer surfaces of the stud 1. The residual heat in the interface between the solder and the conductive material 14 is spread over this relatively large interface such that the intensity of heat applied to the underlying glass 15 is much reduced.

The version of stud illustrated in Figure 5 is generally similar to

that shown in Figures 1-4 and like parts are therefore given the same reference numerals as in Figures 1-4, except that the stud of Figures 5 has no lateral slits. The Figure 5 version differs in that the rim 5 has two complementary frusto-conical parts 50 and 60. Part 50 has its narrower diameter at the end in contact with the periphery of the base plate 7 and its wider diameter in contact with part 60 at its wider diameter. The wider diameter of part 60 is slightly greater than the wider diameter of part 50, creating a projecting ridge 130 where the said parts join. The total rim portion 50, 60, 130 provides for a convenient attachment of a complementary connecting clip generally similar to that of figures 6-9. The frusto-cone surface 50 is helpful in aligning the clip prior to pushing it into position on the stud. The projecting ridge 130 is of a configuration which permits a firm grip with peripheral teeth on the clip.

The complementary clip shown in figures 6 to 9 is for use with a stud as described above with reference to Figure 1 to 5. This complementary clip, indicated generally by reference numeral 2, comprises a flat plate 20 with a circular end portion 21 of slightly greater diameter than the ridge 13 of the terminal stud. The side of the circular portion 21 intended to abut the stud carries six peripheral teeth 22 each having an inwards-projecting ridge 25 shaped to snap over the stud ridge 13 when the clip is pressed over the stud. At the opposite end from the circular portion 21 the flat plate 20 carries sets 23 and 24 of securing bands to receive the end of an electrical supply wire (not shown) and to be crimped to the wire when it is in position.

The illustrated stud and clip provide a low profile stud which is easily applied to a required surface and which is especially easy to apply by means of robots. Application of the stud to a conductor on a glass surface carries a very low risk of heat damage to the glass. The conical shape of the hollow which receives the solder serves to contain it and to prevent unsightly leakages. The soldered stud adheres very strongly to the required surface. Tests have shown that a force of 270 N is required to detach it, well above the level of force it is likely to receive. The high adhesion is moreover obtained without the need for unattractive enlargement of the stud. Indeed its shape is such that it does not require to be hidden by such means as encapsulation. The stud in transit on a coated glass sheet is of a shape which is most unlikely to cause any damage to adjacent sheets or other articles.

Figures 10 and 11 illustrate a cap indicated generally by reference numeral 30. Such a cap promotes the aesthetic appearance of the fastened stud and corresponding clip and may electrically insulate them, provided it is made of an appropriate insulating material.

CLAIMS

1. A metallic terminal stud to be applied to an electrically conductive material (14) on a glass surface (15), characterised in that the stud comprises a hollowed base plate (7) to receive solder to secure the stud to the conductive material (14), the said base plate (7) having an outer periphery to contact the conductive material (14), the stud further comprising a rim (4) extending from the said outer periphery in a direction externally to the said base plate (7) to provide an attachment for a connecting clip (2) of an electrical supply lead.

2. A terminal stud as claimed in claim 1, in which the part of the base plate (7) to contact the conductive surface (14) includes at least one groove (11).

3. A terminal stud as claimed in claim 1 or claim 2, having at least one orifice (9) extending through the base plate (7).

4. A terminal stud as claimed in claim 3, having a single orifice (9) which is substantially central to the hollow region.

5. A terminal stud as claimed in claim 4, in which the orifice (9) is of circular shape.

6. A terminal stud as claimed in claim 3 or 4, in which the base plate has a single orifice (29) of generally cruciform shape.

7. A terminal stud as claimed in claim 6, in which the orifice (29) includes a central generally circular portion.

8. A terminal stud as claimed in any preceding claim, which is shaped to form a snap fastener with the connecting clip (2).

9. A terminal stud as claimed in any preceding claim, in which the outer rim (4) is in the shape of a cone, truncated at the periphery of the base plate (7).

10. A terminal stud as claimed in any preceding claim, in which the outer rim (4) has a ridge (13) to which the connecting clip (2) can be attached.

11. A terminal stud as claimed in any preceding claim, having a circular cross-section in a plane parallel to the plane of the glass surface (15).

12. A terminal stud as claimed in claim 9, in which the outer rim (4) comprises a cylindrical part (5) and a frusto-conical part (6) with the wider diameter of the frusto-conical part (6) joined to the cylindrical part (5)to create the ridge (13).

13. A terminal stud as claimed in claim 9, in which the outer rim (40) comprises two frusto-conical parts (50, 60) inverted with respect to each other and with their wider diameters in abutment to create the ridge (130).

14. A terminal stud as claimed in any preceding claim, in which the rim (5) is provided with slits extending perpendicularly from the periphery of the base-plate (7) to the top of the rim.

15. A terminal stud as claimed in any preceding claim, which is made of a Cu-based material.

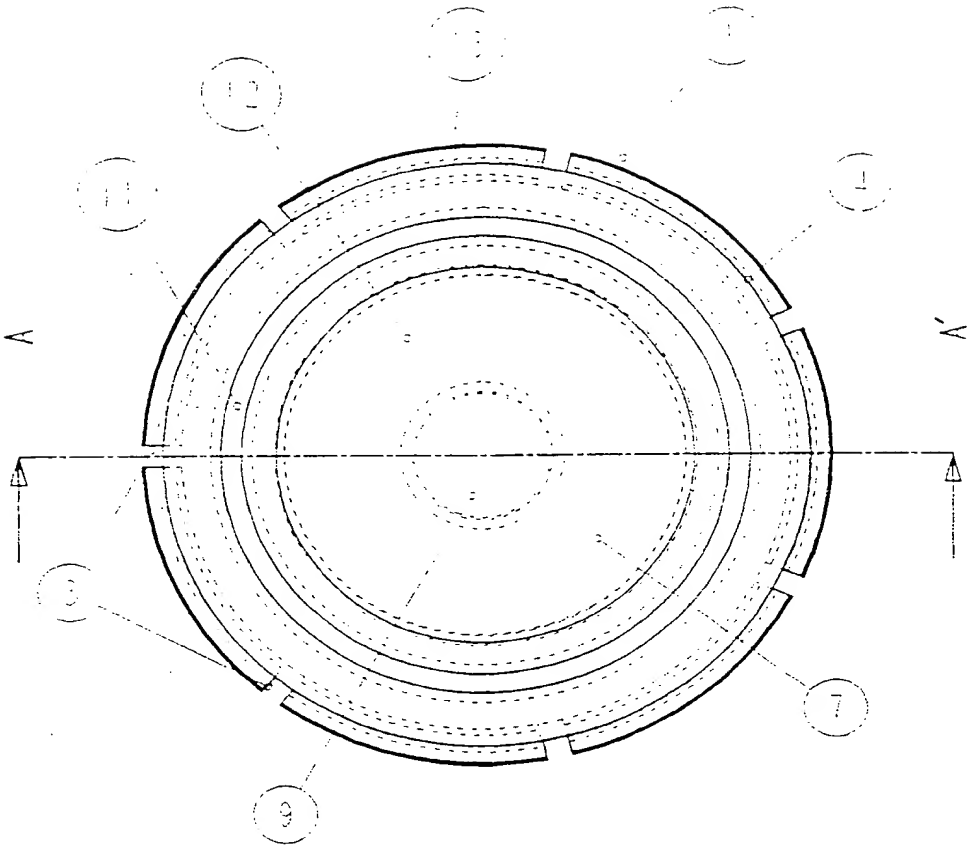

fig.1

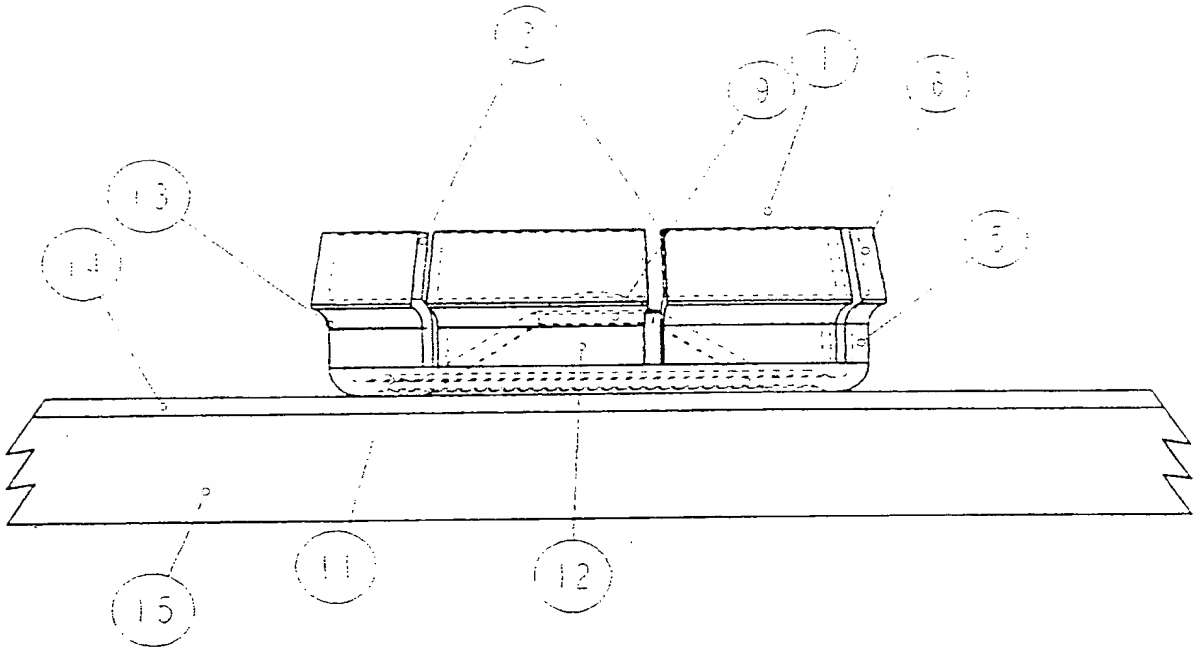

fig.2

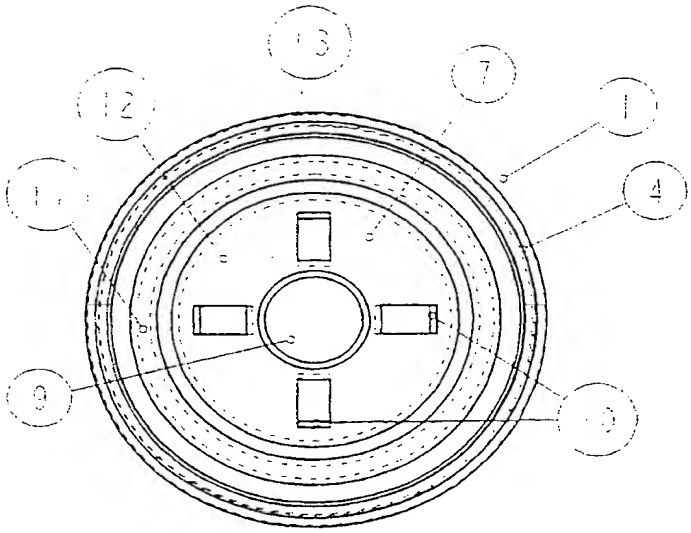

fig.3

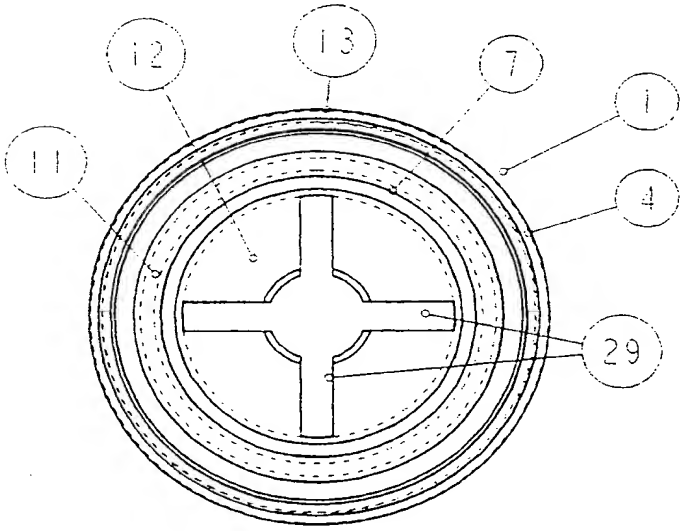

fig.4

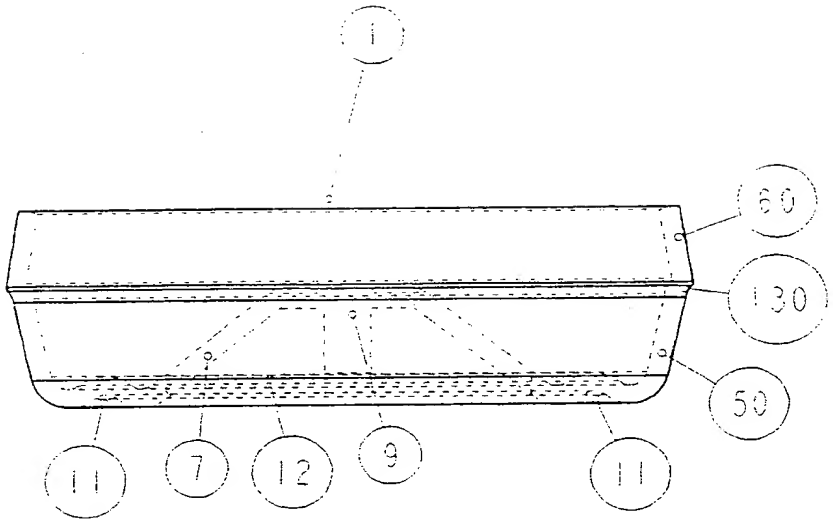

fig.5

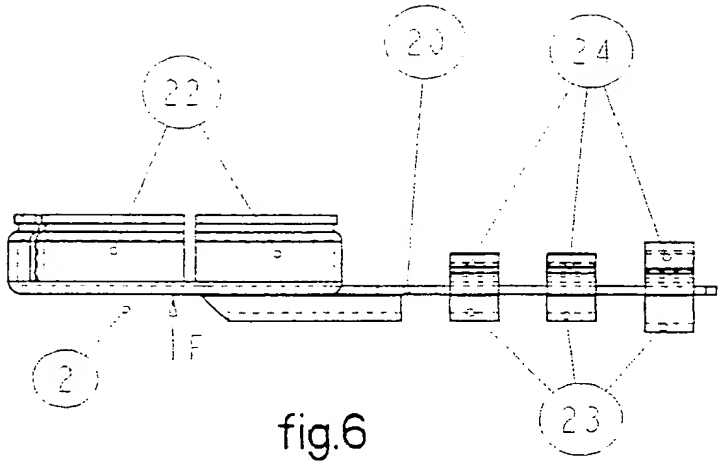

fig.6

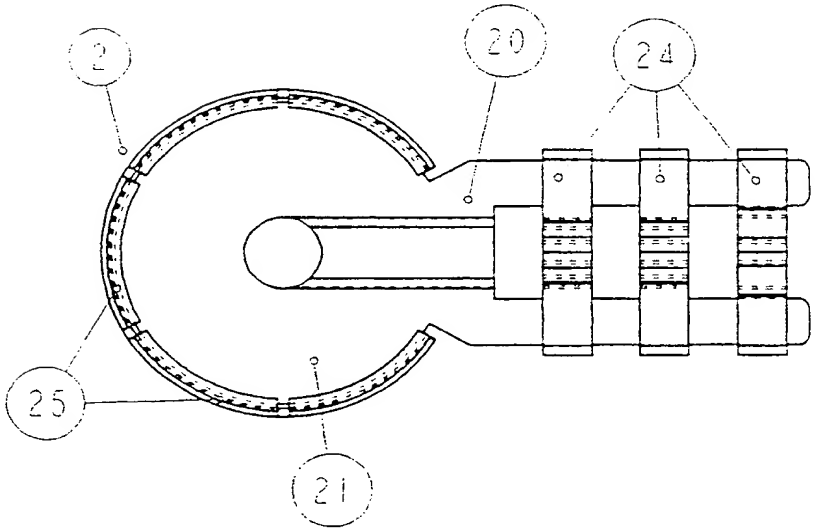

fig.7

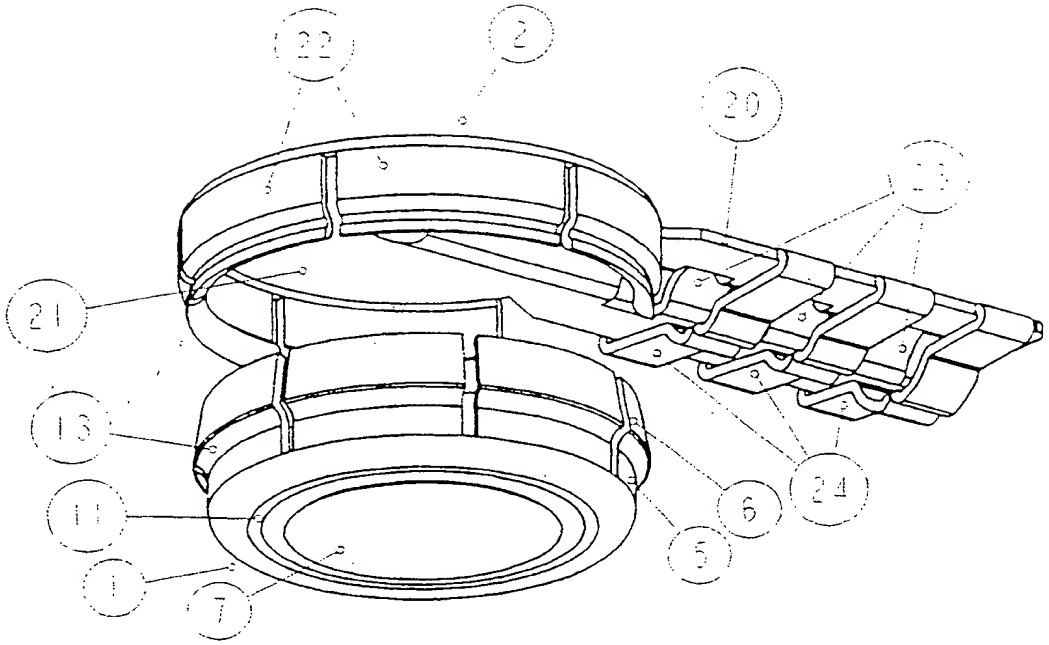

fig.8

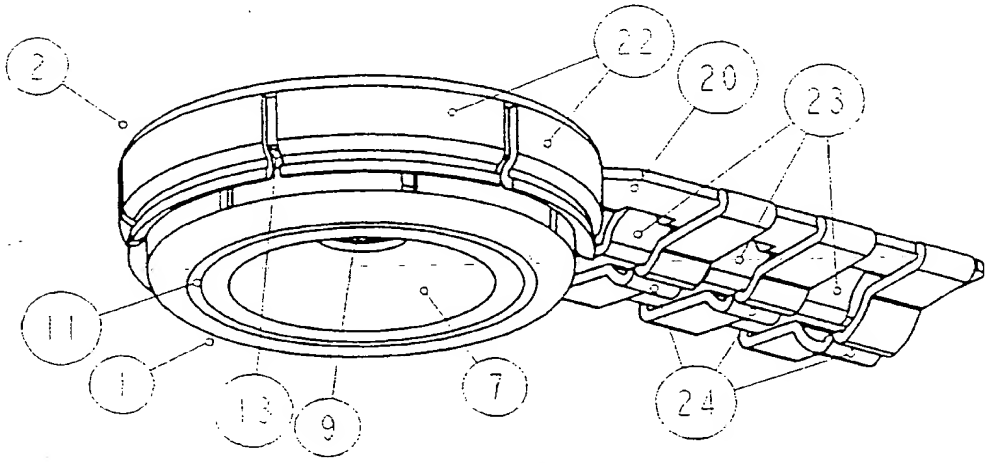

fig.9

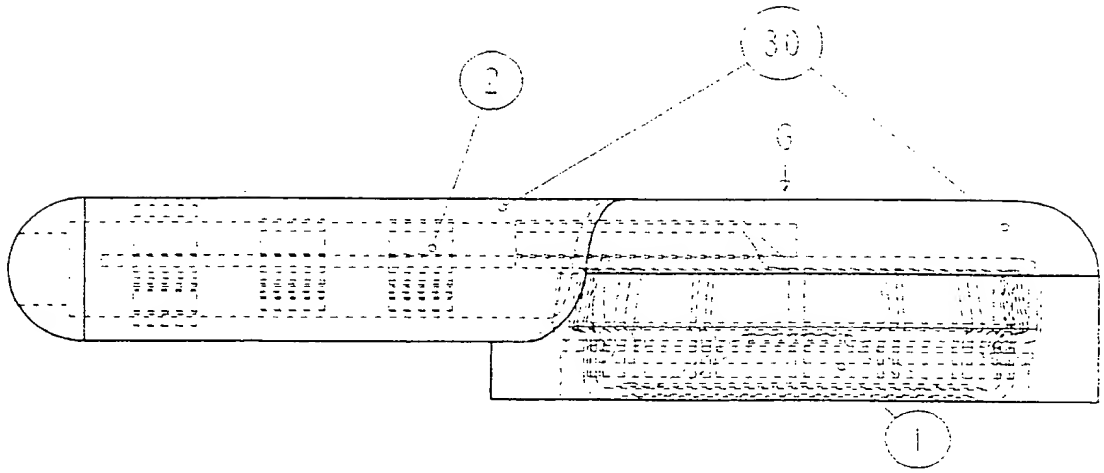

fig.10

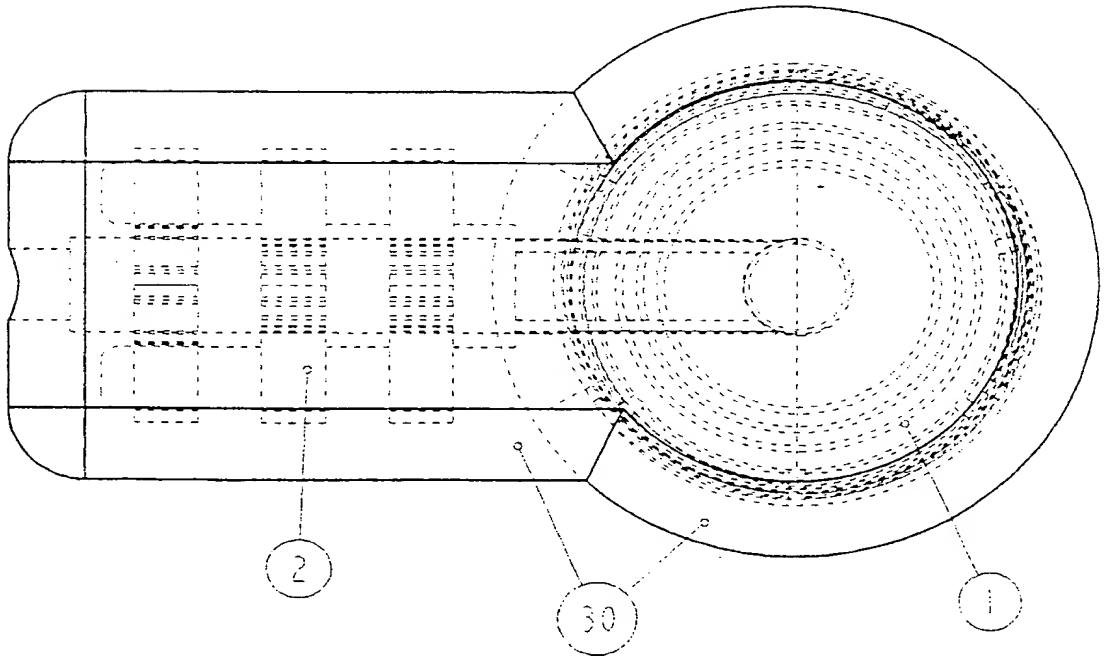

fig.11

INTERNATIONAL SEARCH REPORT

ernational Application No
PCT/BE 98/00052

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H01R4/02 H05B3/84

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H01R H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5 411 236 A (MORITA SHIGEHIRO ET AL) 2 May 1995 see column 1, line 58 - column 2, line 2; figures 5-8	1-5
Y	DE 93 13 394 U (VER GLASWERKE GMBH) 28 October 1993 see page 8, line 5 - line 17; figures 2,5	1-5
A	US 3 980 388 A (NAILOR III WILLIAM KIRBY) 14 September 1976 see column 2, line 22 - line 47; figure 2	1,8-15

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
23 July 1998	10/08/1998

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Criqui, J-J

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INTERNATIONAL SEARCH REPORT

Information on patent family members

ernational Application No
PCT/BE 98/00052

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5411236 A	02-05-1995	NONE	
DE 9313394 U	28-10-1993	DE 4235063 A	21-04-1994
		DE 59308160 D	26-03-1998
		EP 0593940 A	27-04-1994
		ES 2113982 T	16-05-1998
US 3980388 A	14-09-1976	US 4024953 A	24-05-1977